

CLAIMS

1. An air refrigerant cooling apparatus comprising:

a motor having a first magnetic bearing
5 and a second magnetic bearing for supporting a shaft;

a compressor; and

an expansion turbine,

wherein said compressor is connected to
10 said shaft and separated from said first magnetic bearing by a first labyrinth,

said expansion turbine is connected to said shaft and separated from said second magnetic bearing by a second labyrinth, and

15 pressure differences are generated between spaces where said first magnetic bearing and said second magnetic bearing are provided and respective of an inlet of said compressor and an outlet of said expansion turbine by an external
20 pressure outside said motor.

2. The air refrigerant cooling apparatus according to claim 1, further comprising sensors for detecting a position of said shaft,

25 wherein said sensors are provided adjacent to said first magnetic bearing and said second magnetic bearing, and

a pressure difference is generated between a space where said sensors are provided and an outside of a casing of said motor by an external pressure outside said motor.

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3. An air refrigerant cooling apparatus comprising:

a motor having a first magnetic bearing and a second magnetic bearing for supporting a
10 shaft;
a compressor;
an expansion turbine; and
a means for generating pressure differences between spaces where said first
15 magnetic bearing and said second magnetic bearing are provided and respective of an inlet of said compressor and an outlet of said expansion turbine,

wherein said compressor is connected to
20 said shaft and separated from said first magnetic bearing by a first labyrinth, and
said expansion turbine is connected to said shaft and separated from said second magnetic bearing by a second labyrinth.

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4. The air refrigerant cooling apparatus according to claim 3, further comprising:

sensors for detecting a position of said shaft, said sensors provided adjacent to said first magnetic bearing and said second magnetic bearing; and a means for generating a pressure
5 difference between a space where said sensors are provided and an outside of a casing of said motor.

5. An air refrigeration system comprising:
10 the air refrigerant cooling apparatus according to any one of claims 1 to 4;

a first heat exchanger;
a second heat exchanger;
a refrigerator;
15 a filter; and
a fan,

wherein an outlet of said compressor in said air refrigerant cooling apparatus is connected to an inlet of said first heat
20 exchanger,

an outlet of said first heat exchanger is connected to an inlet of said second heat exchanger,

an outlet of said second heat exchanger is
25 connected to an inlet of said expansion turbine in said air refrigerant cooling apparatus,

an outlet of said expansion turbine in

said air refrigerant cooling apparatus is
connected to an inlet of said refrigerator,
an outlet of said refrigerator is
connected to an inlet of said compressor in said
5 air refrigerant cooling apparatus through said
second heat exchanger, and

said fan supplies fluid into a casing of
said motor through said filter.

10 6. An air refrigeration system comprising:
the air refrigerant cooling apparatus
according to any one of claims 1 to 4;

a first heat exchanger;
a second heat exchanger;
15 a refrigerator; and
a radiator,

wherein an outlet of said compressor in
said air refrigerant cooling apparatus is
connected to an inlet of said first heat
20 exchanger,

an outlet of said first heat exchanger is
connected to an inlet of said second heat
exchanger,

an outlet of said second heat exchanger is
25 connected to an inlet of said expansion turbine
in said air refrigerant cooling apparatus,
an outlet of said expansion turbine in

said air refrigerant cooling apparatus is
connected to an inlet of said refrigerator,

an outlet of said refrigerator is
connected to an inlet of said compressor in said
5 air refrigerant cooling apparatus through said
second heat exchanger,

said radiator is provided outside said air
refrigerant cooling apparatus, and

an inlet and an outlet of said radiator
10 are connected to air vents which are provided on
a casing of said motor and associated with
respective of said inlet and said outlet of said
radiator.

15 7. An air refrigeration system comprising:
the air refrigerant cooling apparatus
according to any one of claims 1 to 4;

a first heat exchanger;
a second heat exchanger; and
20 a refrigerator,

wherein an outlet of said compressor in
said air refrigerant cooling apparatus is
connected to an inlet of said first heat
exchanger,

25 an outlet of said first heat exchanger is
connected to an inlet of said second heat
exchanger,

an outlet of said second heat exchanger is connected to an inlet of said expansion turbine in said air refrigerant cooling apparatus,

an outlet of said expansion turbine in
5 said air refrigerant cooling apparatus is connected to an inlet of said refrigerator,

an outlet of said refrigerator is connected to an inlet of said compressor in said air refrigerant cooling apparatus through said
10 second heat exchanger,

a conduit connected to said outlet of said second heat exchanger is branched for cooling down an inside of said motor,

said branched conduit is connected to an
15 air vent provided on a casing of said motor, and

said inlet of said compressor in said refrigerant cooling apparatus is connected to another air vent provided on said casing.

20 8. A refrigerator container comprising:
the air refrigerant cooling apparatus according to any one of claims 1 to 4;

a first heat exchanger;

a second heat exchanger;

25 a container box; and

a radiator,

wherein an outlet of said compressor in

said air refrigerant cooling apparatus is connected to an inlet of said first heat exchanger,

an outlet of said first heat exchanger is
5 connected to an inlet of said second heat exchanger,

an outlet of said second heat exchanger is connected to an inlet of said expansion turbine in said air refrigerant cooling apparatus,

10 an outlet of said expansion turbine in said air refrigerant cooling apparatus is connected to an inlet of said container box,

an outlet of said container box is connected to an inlet of said compressor in said
15 air refrigerant cooling apparatus through said second heat exchanger,

said radiator is provided outside said air refrigerant cooling apparatus for cooling down an inside of said motor in said air refrigerant
20 cooling apparatus, and

an inlet and an outlet of said radiator are connected to air vents which are provided on a casing of said motor and associated with respective of said inlet and said outlet of said
25 radiator, and

said air refrigerant cooling apparatus, said first heat exchanger, said second heat

exchanger, said container box, and said radiator are configured to be transportable.

9. An air refrigeration system comprising:
- 5 a first bearing for supporting a shaft;
a compressing mechanism;
an expansion turbine;
a first heat exchanger;
a second heat exchanger; and
10 a first conduit,
wherein an outlet of said compressing mechanism in said air refrigerant cooling apparatus is connected to an inlet of said first heat exchanger,
- 15 an outlet of said first heat exchanger is connected to an inlet of said second heat exchanger,
an outlet of said second heat exchanger is connected to an inlet of said expansion turbine
20 in said air refrigerant cooling apparatus,
an outlet of said expansion turbine in said air refrigerant cooling apparatus is connected to an inlet of said refrigerator,
an outlet of said refrigerator is
25 connected to an inlet of said compressing mechanism through said second heat exchanger,
a compressor in said compressing mechanism

is connected to said shaft and is separated from said first bearing by a first labyrinth,

said expansion turbine is connected to said shaft, and

5 said first conduit supplies an air refrigerant from between an outlet of said compressor and said inlet of said refrigerator to a space where said first bearing is provided.

10 10. The air refrigeration system according to claim 9, further comprising:

 a second bearing supporting said shaft at a position closer to said expansion turbine than said compressor; and

15 a second conduit for supplying said air refrigerant from said space where said first bearing is provided to a space where said second bearing is provided.

20 11. The air refrigeration system according to claim 10, further comprising a third conduit for supplying said air refrigerant from said space where said second bearing is provided to said outlet of said expansion turbine.

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12. The air refrigeration system according to any one of claims 9 to 11, further comprising a

motor for rotating said shaft,

wherein said first bearing and said second bearing are magnetic bearings.

5 13. The air refrigeration system according to any one of claims 9 to 12,

wherein said first conduit is configured to derive said air refrigerant from said inlet of said expansion turbine.

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14. The air refrigeration system according to any one of claims 9 to 11,

said compressing mechanism further includes an auxiliary compressor provided

15 upstream of said compressor.

15. A refrigerator container comprising the air refrigeration system according to any one of claims 9 to 14; and

20 a container box connected to said outlet of said expansion turbine.